

Intermediate Motion Math – For Middle School Learners

1. What is Motion? (Δm)

Let's talk about how we measure motion in math. When something moves from one place to another, we don't look at time—we look at the change in position.

For example:

- If you start at **2 steps** and walk to **5 steps**, how many steps did you take?
- You took **3 steps** forward because **$5 - 2 = 3$** .

This change is called **Δm** (say: "delta m"). It means "**change in motion**" or "**how much something moved**."

Let's walk through more examples:

 **Start at 1, move to 6**

We subtract: **$6 - 1 = 5$** , so **$\Delta m = 5$**

 **Start at 3, move to 8**

$8 - 3 = 5$, so **$\Delta m = 5$**

 **Start at 10, move to 2**

$2 - 10 = -8$, so **$\Delta m = -8$** (this means you moved backwards!)

 **Start at 0, move to 0**

$0 - 0 = 0$, so **$\Delta m = 0$** (you didn't move!)

 **Start at 7, move to 7**

$7 - 7 = 0$, so again, **$\Delta m = 0$**

Now let's try motion using multiplication — this is how we show repeated steps:

 **3 steps per turn \times 2 turns**

$3 \times 2 = 6$ steps

 **4 steps \times 5 turns**

$4 \times 5 = 20$ steps

 **6 steps \times 1 turn**

$6 \times 1 = 6$ steps

 **7 steps \times 0 turns**

$7 \times 0 = 0$ steps (no motion)

👉 **5 steps × 3 turns**

$$5 \times 3 = 15 \text{ steps}$$

These show how multiplication is just motion that repeats.

Try these on your own:

- Start at 4, move to 9 → What's Δm ?
- Start at 10, move to 3 → What's Δm ? (Remember: can Δm be negative?)

+-× 2. Practice: Basic Motion with Math Skills

Let's practice **plus**, **minus**, and **multiplication** with motion:

1. You're at step **2**. Move forward **4** steps. What's your new position?
→ **$2 + 4 = 6$**
2. You're at step **10**. Move backward **3** steps. What's your new position?
→ **$10 - 3 = 7$**
3. You move **2 steps each turn**. After **5 turns**, how far do you go?
→ **$2 \times 5 = 10$ steps**
4. You're at step **1**. Move forward **7** steps.
→ **$1 + 7 = 8$**
5. You're at step **9**. Move backward **4** steps.
→ **$9 - 4 = 5$**
6. Move **3 steps** every time. After **6 turns**?
→ **$3 \times 6 = 18$**
7. You're at **0**, move forward **10** steps.
→ **$0 + 10 = 10$**
8. You're at **15**, move back **5**.
→ **$15 - 5 = 10$**
9. Move **4 steps per turn** for **3 turns**.
→ **$4 \times 3 = 12$**
10. Start at **5**, move **2 steps** forward.
→ **$5 + 2 = 7$**

📈 3. Using Formulas to Show Motion ($y = mx + c$)

This is a common formula in math:

$$y = mx + c$$

Let's break it down like a motion game:

- **M** is how much you move each time (like 2 steps every minute)
- **X** is how many times you repeat that movement
- **C** is where you started (your first position)

1 2
3 4 **Example:**

- Start at position **1**
- Move **2 steps** every time
- Do this **4 times**

$$\rightarrow y = 2 \times 4 + 1 = 9$$

You end up at **position 9**.

Try your own:

- Start at 0, move 5 steps per turn, take 3 turns $\rightarrow y = ?$
- Start at 7, move 1 step per turn, take 6 turns $\rightarrow y = ?$

⊕ 4. Adding Up Motion ($\Sigma\Delta m$)

Sometimes we move step-by-step. Let's say:

- Start at 0
- Move to 2 \rightarrow moved 2
- Move to 5 \rightarrow moved 3
- Move to 9 \rightarrow moved 4

Let's add them:

$$2 + 3 + 4 = 9$$

We call this **$\Sigma\Delta m$** (sum of all movements).  Σ is just a symbol that means "add them up."

More practice:

- Moves: 1 \rightarrow 4 \rightarrow 7 \rightarrow 10 \rightarrow Δm 's are?
- What is the total distance moved?

5. Bob's Walk Word Problem

Let's look at how Bob's daily walk can help us understand math and motion. Imagine Bob moves the same number of steps every time. We can calculate how far he goes based on how many times he moves.

Example 1: Bob starts at spot 2. He moves 3 steps forward every turn. If he moves for 4 turns, how far does he go?

 Use this formula:

$$\text{Final Spot} = \text{Start} + (\Delta m \times \text{Turns})$$

So: $\rightarrow 2 + (3 \times 4) = 2 + 12 = 14$ Bob ends up at **spot 14**.

Example 2: Bob starts at **5**. He moves **4 steps forward** each turn. He takes **3 turns**. $\rightarrow 5 + (4 \times 3) = 5 + 12 = 17$ Bob ends at **17**.

Example 3: Bob starts at **12**. He moves **2 steps backward** each turn. He does this for **4 turns**.
 $\rightarrow 12 + (-2 \times 4) = 12 - 8 = 4$ Bob ends at **4**.

Let's try a few more:

Example 4: Bob starts at **0** and moves **5 steps forward** for **5 turns**. $\rightarrow 0 + (5 \times 5) = 25$

Example 5: Bob starts at **7** and moves **3 steps backward** for **2 turns**. $\rightarrow 7 + (-3 \times 2) = 7 - 6 = 1$

These examples show how we can use math to model Bob's motion using simple multiplication and addition. It's like mapping his walk with equations!

6. Why This Works (And Why It's Important)

Motion-based math isn't just about getting correct answers—it helps us understand how change works, and how we interact with it every day.

Motion Is the Language of Change

When something moves, grows, increases, or decreases, it's undergoing change. That change can be measured, tracked, and predicted. Math is the tool we use to model those patterns, but motion is the real-world truth behind it.

Math That Reflects Reality

This system shows not just where something is, but how it got there and where it's likely going. It helps us:

- Understand progress (like savings or growth)
- Predict outcomes (like travel distance or performance)
- Track cause and effect (like how input changes output)

Why This Builds Trust

When learners understand motion:

- They feel more confident in math
- They stop seeing it as random symbols
- They begin to model their own world logically

This also lays the foundation for more advanced ideas like speed, acceleration, and systems thinking, while staying grounded in everyday life.

 Learning motion math is learning how to think clearly about change. It's a skill that applies far beyond school. It builds structure, reveals patterns, and supports smart decision-making.

🌀 7. Change of the Change ($\Delta\Delta m$)

Sometimes, motion isn't just about how far you go — it's about how your motion itself is changing. This is called the change of the change, or $\Delta\Delta m$.

What Does That Mean?

Let's break it down.

Imagine you take steps like this:

- Step 1: Move 2 steps
- Step 2: Move 2 steps again
- Step 3: Move 2 steps again

You're moving the **same amount** each time. That means your change isn't changing. So:  $\Delta m = 2$, and $\Delta\Delta m = 0$ (no change in your change)

Now let's look at this:

- Step 1: Move 1 step
- Step 2: Move 2 steps
- Step 3: Move 3 steps

Let's find Δm between each step:

- From 1 to 2 → $\Delta m = 1$
- From 2 to 3 → $\Delta m = 1$

But what if the steps looked like this?

- Step 1: Move 1 step
- Step 2: Move 3 steps
- Step 3: Move 6 steps

Now the Δm 's are:

- From 1 to 3 → $\Delta m = 2$
- From 3 to 6 → $\Delta m = 3$

So what is the change of the change? → **$\Delta\Delta m = 3 - 2 = 1$**

That means your motion is speeding up. Your steps are getting bigger and bigger each time.



Try it Yourself:

1. Move: 2, 4, 6 → What are the Δm 's? Then what is $\Delta\Delta m$?
2. Move: 1, 3, 7 → What are the Δm 's? Then what is $\Delta\Delta m$?
3. Move: 10, 10, 10 → What's Δm and $\Delta\Delta m$?

You just discovered **acceleration** — and you didn't even need to learn physics to do it!



8. How Motion Math Shows Up in Real Life

Math isn't just for numbers on a page—it shows up **everywhere** around you, especially when things move or change. Let's look at some real-life examples and how to use Δm to understand them.



Example 1: Climbing Stairs

You climb from step 1 to step 10.

- Start = 1
- End = 10
- $\Delta m = 10 - 1 = 9 \text{ steps}$ climbed

Now imagine you climb the same number of stairs every day. You go up **9 steps** each day for **5 days**.

- Total steps = $9 \times 5 = 45 \text{ steps}$

Example 2: Saving Money in a Piggy Bank

You save \$2 every week.

- Δm per week = \$2 After 6 weeks:
- Total saved = $2 \times 6 = \$12$

Now what if you started with \$5 already in your bank?

- Final total = $5 + (2 \times 6) = \$17$

Example 3: Plant Growing Taller

A plant is 10 cm tall. Every week, it grows 3 cm taller. After 4 weeks:

- Growth = $3 \times 4 = 12$ cm
- Final height = $10 + 12 = 22$ cm

Example 4: Temperature Change

It's morning and the temperature is 15°C. By noon, it's 23°C.

- $\Delta m = 23 - 15 = 8^\circ\text{C}$ rise

Later, it cools back to 18°C.

- $\Delta m = 18 - 23 = -5^\circ\text{C}$ drop

Example 5: Score in a Video Game

You earn 100 points per level. You play 4 levels:

- Total score = $100 \times 4 = 400$ points

Then you lose 50 points from a penalty:

- Final score = $400 - 50 = 350$ points

These show that motion math isn't just math—it's a way to understand the world. You can use Δm and repeated steps to see how things grow, move, rise, fall, or build.

Quiz Sheet

1. You walk from step 8 to step 11.

How many steps did you move? What is your Δm ?

2. You are standing at step 5. Then you walk forward 6 steps.

Where do you end up?

3. You begin at step 20. You move backward by 7 steps.

Where do you land?

4. Bob moves forward 2 steps every turn. He starts at step 3. After 5 turns,

Where will Bob be?

5. You start at step 6, move to 10, and then move again to 15.

What are the Δm values between each move? What is the total distance you moved?

 Use paper or your brain to solve each one!

Answer Key:

Section 1:

- $4 \rightarrow 9 \rightarrow \Delta m = 5$
- $10 \rightarrow 3 \rightarrow \Delta m = -7$
- $3 \times 2 = 6$
- $4 \times 5 = 20$
- $6 \times 1 = 6$
- $7 \times 0 = 0$
- $5 \times 3 = 15$

Section 3 (Try Your Own):

- $0 + (5 \times 3) = 15$
- $7 + (1 \times 6) = 13$

Section 4 (More Practice):

- $\Delta m's = 3, 3, 3 \rightarrow \text{Total} = 9$

Section 5 (Bob):

- $5 + (4 \times 3) = 17$
- $12 + (-2 \times 4) = 4$

Section 7 ($\Delta\Delta m$ Practice):

1. $\Delta m: 2, 2 \rightarrow \Delta\Delta m = 0$
2. $\Delta m: 2, 4 \rightarrow \Delta\Delta m = 2$
3. $\Delta m = 0, \Delta\Delta m = 0$

Quiz Sheet:

1. $11 - 8 = 3 \rightarrow \Delta m = 3$
2. $5 + 6 = 11$
3. $20 - 7 = 13$
4. $3 + (2 \times 5) = 13$
5. $\Delta m = 4$, then $\Delta m = 5 \rightarrow \text{Total} = 9$

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